

ABSTRACT

Recent data compiled by the National Bridge Inventory revealed 29% of Iowa's approximate 24,600 bridges were either structurally deficient or functionally obsolete. This large number of deficient bridges and the high cost of needed repairs create unique problems for Iowa and many other states. The research objective of this project was to determine the load capacity of a particular type of deteriorating bridge – the precast concrete deck bridge – which is commonly found on Iowa's secondary roads. The number of these precast concrete structures requiring load postings and/or replacement can be significantly reduced if the deteriorated structures are found to have adequate load capacity or can be reliably evaluated.

Approximately 600 precast concrete deck bridges (PCDBs) exist in Iowa. A typical PCDB span is 19 to 36 ft long and consists of eight to ten simply supported precast panels. Bolts and either a pipe shear key or a grouted shear key are used to join adjacent panels. The panels resemble a steel channel in cross-section; the web is orientated horizontally and forms the roadway deck and the legs act as shallow beams. The primary longitudinal reinforcing steel bundled in each of the legs frequently corrodes and causes longitudinal cracks in the concrete and spalling.

The research team performed service load tests on four deteriorated PCDBs; two with shear keys in place and two without. Conventional strain gages were used to measure strains in both the steel and concrete, and transducers were used to measure vertical deflections. Based on the field results, it was determined that these bridges have sufficient lateral load distribution and adequate strength when shear keys are properly installed between adjacent panels. The measured lateral load distribution factors are larger than AASHTO values when shear keys were not installed. Since some of the reinforcement had hooks, deterioration of the reinforcement has a minimal affect on the service level performance of the bridges when there is minimal loss of cross-sectional area.

Laboratory tests were performed on the PCDB panels obtained from three bridge replacement projects. Twelve deteriorated panels were loaded to failure in a four point bending arrangement. Although the panels had significant deflections prior to failure, the experimental capacity of eleven panels exceeded the theoretical capacity. Experimental capacity of the twelfth panel, an extremely distressed panel, was only slightly below the theoretical capacity. Service tests and an ultimate strength test were performed on a laboratory bridge model consisting of four joined panels to determine the effect of various shear connection configurations. These data were used to validate a PCDB finite element model that can provide more accurate live load distribution factors for use in rating calculations. Finally, a strengthening system was developed and tested for use in situations where one or more panels of an existing PCDB need strengthening.